PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P/63956/U64	**FOR FURTHER ACTION**	See Form PCT/IPEA/416
International application No. PCT/EP2004/052641	International filing date *(day/month/year)* 22.10.2004	Priority date *(day/month/year)* 25.10.2003
International Patent Classification (IPC) or national classification and IPC H04B10/17, H04J14/02		
Applicant MARCONI COMMUNICATIONS GMBH et al		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 6 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *sent to the applicant and to the International Bureau)* a total of 6 sheets, as follows:
      ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

☒	Box No. I	Basis of the opinion
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☐	Box No. VIII	Certain observations on the international application

Date of submission of the demand 18.08.2005	Date of completion of this report 28.02.2006
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer Petitit, N Telephone No. +49 89 2399-7715

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/EP2004/052641

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

   ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
   - ☐ international search (under Rules 12.3 and 23.1(b))
   - ☐ publication of the international application (under Rule 12.4)
   - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages

1-3, 6-11	as originally filed
4, 5	received on 18.08.2005 with letter of 17.08.2005

Claims, Numbers

1-8	received on 18.08.2005 with letter of 17.08.2005

Drawings, Sheets

1/2	as originally filed
2/2	received on 18.08.2005 with letter of 17.08.2005

☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☐ The amendments have resulted in the cancellation of:
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

* *If item 4 applies, some or all of these sheets may be marked "superseded."*

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-8
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-8
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-8
	No:	Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Re Item V

1. Reference is made to the following documents:
   D1: WO 02/091027 A2 (CIENA CORPORATION) 14 November 2002;
   D2: US 2002/110318 A1 (WU WEITI ET AL) 15 August 2002.

2. The document D1 is regarded as being the closest prior art to the subject-matter of claim 1, and shows (the references in parentheses applying to this document):

   An amplifier node (figure 3: node containing "54_3", "50_3", "62_3" and "64_3") for an optical network (The system of figure 3 is an optical communication network) having at least one input port (figure 3: input to "54_3") for receiving an optical wavelength-multiplex signal (page 5, lines 13-16: "the optical communications system is a WDM system") that is fed to a structure comprising a demultiplexer and a multiplexer (figure 3: add-drop multiplexer "54_3"), wherein the demultiplexer is adapted to split the received optical wavelength-multiplex signal at least into payload channels (The purpose of an optical WDM communication system is to transport payload channels between nodes. Add-drop multiplexer "54_3" splits channels, including said payload channels) and a supervisory channel (figure 3: service channel for the communications device "62". Figure 3 shows a link between add-drop multiplexer "54_3" and communications device "62_3" for the service channel), and the multiplexer is adapted to assemble an optical wavelength-multiplex signal to be transmitted from the at least payload channels and the supervisory channel (reverse function of add-drop multiplexer "54_3" detailed above); and an amplifier (figure 3: "50_3"), the structure having four gates, wherein at a first gate the incoming wavelength-multiplex signal is received (figure 3: input of "54_3"), at a second gate the supervisory channel is output to the amplifier (figure 3: output of "54_3"), and at a fourth gate a recombined supervisory channel and the payload channels are supplied (figure 3: output of "54_3").

   The subject-matter of claim 1 differs from this known system in that

   The amplifier node of claim 1 also comprises:

a pre-amplifier before the demultiplexer;

a dispersion compensator after the multiplexer;

a post-amplifier after the dispersion compensator; and

a continuous, wavelength selective reflective structure wherein said multiplexer-demultiplexer are merged, so that

the supervisory channel output from the demultiplexer into the amplifier is input again from the amplifier into the multiplexer; and

the structure is adapted to split off and to insert, as the supervisory channel, a wavelength, the attenuation of which between the input port and the amplifier is essentially the same in the pumped and unpumped states of the pre-amplifier and post-amplifier.

The subject-matter of claim 1 is therefore new (Article 33(2) PCT).

The problem to be solved by the present invention may be regarded as

How to optimize the transport of a supervisory channel in an optical WDM communication system comprising add-drop multiplexers.

The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT) for the following reasons:

Although the use of pre- and post-amplifiers in an add-drop node of an optical WDM communication system is known to the skilled person, none of the known prior art hints at:

separating the supervisory channel from the payload channels in order to amplify the supervisory channel separately and recombine it with the

payload channels; and

selecting a supervisory channel wavelength so that its attenuation between the input port of the demultiplexer and the amplifier is essentially the same in the pumped and unpumped states of the pre-amplifier and post-amplifier.

3. Independent system claim 6, corresponding to apparatus claim 1, meets the requirements of novelty (Article 33(2) PCT) and inventive step (Article 33(3) PCT) for the same reasons.

4. Claims 2-5 and 7-8 are dependent on claims 1 and 6 respectively, and as such also meet the requirements of the PCT with respect to novelty and inventive step.

amplifiers at the beginning and the end of a transmission fibre fails, this not only prevents transmission of the payload channels, but also the available power of the supervisory channel at the receiver node decreases, so that it can no longer be reliably processed, whereby the detection of the failure and its causes as well as the repair thereof is made considerably more difficult, if not impossible.

The object of the present invention is to provide a solution to this problem.

The solution of the invention is in the judicious choice of a wavelength for the supervisory channel.

According to a first aspect of the present invention there is provided an amplifier node for an optical network as claimed in claim 1.

Considering the receiver side of an amplifier node, the wavelength which is branched off the wavelength division multiplex by the demultiplexer as the supervisory channel should be selected such that its attenuation between the entry port and the sink receiving the supervisory channel is essentially the same in the pumped and unpumped states of the amplifier.

Considering the output side of such an amplifier node, a criterion for the wavelength of the supervisory channel is that the attenuation between the source of the supervisory channel and the exit port should be essentially the same in the pumped and unpumped states of the amplifier.

This wavelength may slightly differ from the wavelength at which the attenuation of the amplifier alone is the same in the pumped and unpumped states, since on the optical

path between the entry port and the sink or between the source and exit port components with wavelength-dependent attenuation such as curved waveguides might be present. If the design of transmitter and receiver sides of the network nodes is sufficiently symmetrical, the two above criteria for the wavelength of the supervisory channel are equivalent.

According to a first aspect of the present invention there is provided an optical network as claimed in claim 6.

If not only the isolated amplifier node is considered, but, instead, a complete network in which a transmitter node and an amplifier node are connected by an optical fibre, this fibre may also have a wavelength-dependent attenuation which influences the optimum wavelength for the supervisory channel. In this case, the wavelength for the supervisory channel should be selected such that a total attenuation experienced by the supervisory channel on the way from a source to a sink is independent of whether an amplifier located along its path is pumped or unpumped.

If the amplifier is an erbium-doped fibre amplifier, the wavelength of the supervisory channel is preferably selected between 1600 and 1650 nm, in particular between 1610 and 1650 nm.

In order make the bandwidth that may be used for the payload data channels of the wavelength division multiplex broader than the range in which the amplification by an active medium of the amplifier by itself is essentially independent of the wavelength, a gain-equalizing filter may be serially combined with the active medium. This filter must then also be transparent at the wavelength of the supervisory channel so as not to suppress it.

Claims

1. An amplifier node for an optical network having at least one input port for receiving an optical wavelength-multiplex signal that is fed to a pre-amplifier (8), a continuous, wavelength-selectively reflective structure (18) comprising merged demultiplexer and multiplexer, wherein the demultiplexer is adapted to split the received optical wavelength-multiplex signal at least into payload channels and a supervisory channel, and the multiplexer is adapted to assemble an optical wavelength-multiplex signal to be transmitted from the at least payload channels and the supervisory channel; an amplifier (11), a dispersion compensator (23) and a post-amplifier (13), the continuous, wavelength-selectively reflective structure (18) having four gates, wherein at a first gate (19) the incoming wavelength-multiplex signal is received from the pre-amplifier (8), at a second gate the supervisory channel is output to the amplifier (11), at a third gate (21) the supervisory channel is received from the amplifier (11) and at a fourth gate (22) a recombined supervisory channel and the payload channels are supplied via the dispersion compensator (23) to the post-amplifier (13) and the continuous, wavelength-selectively reflective structure (18) is adapted to split off and to insert, as the supervisory channel, a wavelength, the attenuation of which between the input port and the amplifier (11) is essentially the same in the pumped and unpumped states of the pre-amplifier (8) and post-amplifier (13).

2. An amplifier node of claim 1, wherein the amplifier (8, 13) is an erbium-doped fibre amplifier, and that the wavelength of the supervisory channel is between 1600 and 1650 nm, preferably between 1610 and 1650 nm.

3. The amplifier node according to one of the preceding claims, wherein the amplifier (8, 13) comprises an active medium in series with a filter for levelling the gain of the active medium in the wavelength band of the payload channels, and that the levelling filter is transparent for the supervisory channel.

4. The amplifier node of claim 3, wherein in the amplifier (8) the active medium is placed before the filter.

5. The amplifier node of claim 3, wherein in the amplifier (8) the active medium is placed behind the filter.

6. An optical network comprising a transmitter node, a receiver node and an optical fibre (3) for transmitting an optical wavelength-multiplex signal comprising payload channels and a supervisory channel, wherein at least one input port for receiving an optical wavelength-multiplex signal that is fed to a pre-amplifier (8), a continuous, wavelength-selectively reflective structure (18) comprising merged demultiplexer and multiplexer, wherein the demultiplexer is adapted to split the received optical wavelength-multiplex signal at least into payload channels and a supervisory channel, and the multiplexer is adapted to assemble an optical wavelength-multiplex signal to be transmitted from the at least payload channels and the supervisory channel; an amplifier (11), a dispersion compensator (23) and a post-amplifier (13), the continuous, wavelength-selectively reflective structure (18) having four gates, wherein at a first gate (19) the incoming wavelength-multiplex signal is received from the pre-amplifier (8), at a second gate the supervisory channel is output to the amplifier (11), at a third gate (21) the supervisory channel is received from the amplifier (11) and at a fourth gate (22) a recombined supervisory channel and the payload channels are supplied via the dispersion compensator (23) to the post-amplifier (13), and the receiver node (4) comprises a sink (16) for the supervisory channel and a demultiplexer (14) for splitting the wavelength-multiplex signal into the supervisory channel and the payload channels, wherein the multiplexer and demultiplexer (12, 14) are adapted to insert and extract, respectively, as the supervisory channel, a wavelength into/from the optical multiplex signal, the attenuation of which between source (11) and sink (16) is essentially the same in the pumped and unpumped states of the pre-amplifier (8) and post-amplifier (13).

7. The optical network of claim 6, wherein the amplifier (8, 13) is an erbium-doped fibre amplifier, and that the wavelength of the supervisory channel is between 1600 and 1650 nm, preferably between 1610 and 1650 nm.

8. The optical network of claim 6 or 7, wherein the amplifier (8, 13) comprises an active medium in series with a levelling filter for levelling the gains of the payload channels, and that the levelling filter is transparent for the supervisory channel.

Fig. 3

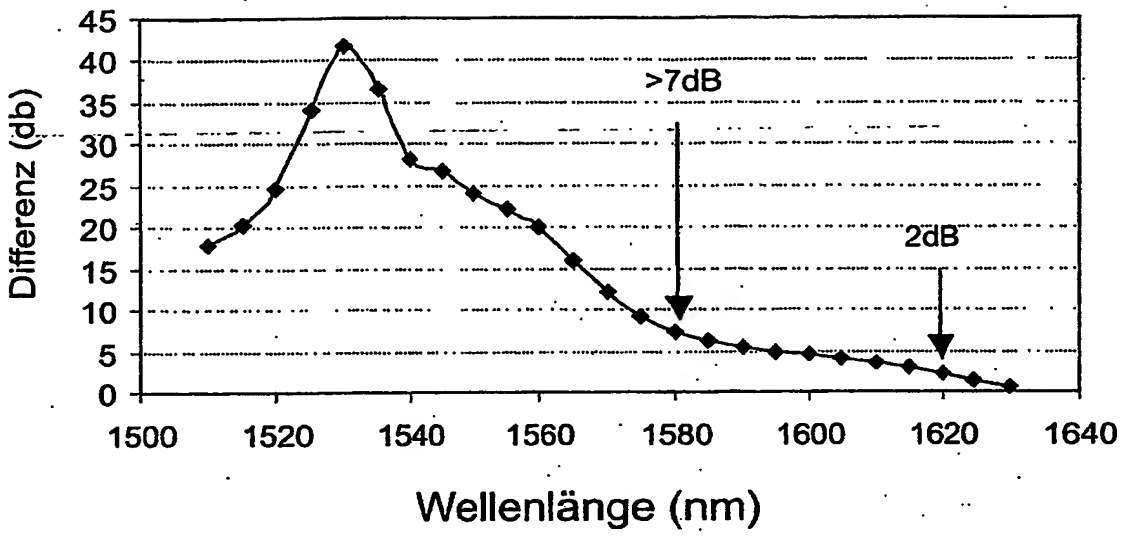
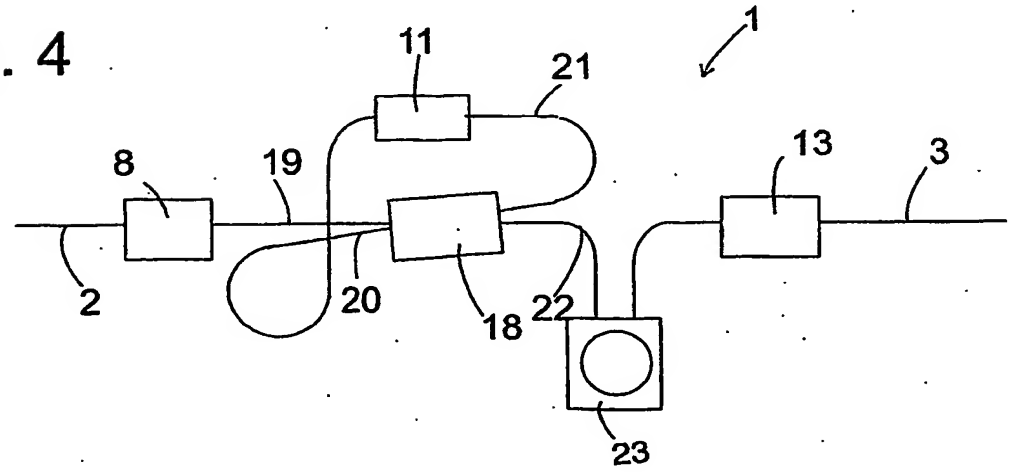

Differenz (db)
45
40
35
30
25
20
15
10
5
0
1500
1520
1540
1560
1580
1600
1620
1640
>7dB
2dB
Wellenlänge (nm)

Fig. 4


1
11
21
8
19
13
3
2
20
18
22
23